Fission Fragment Excitation of Nuclear Isomers in Hot Dense Environments

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High-energy fission fragments are born with kinetic energies of the order of 100 MeV, and, in principle, these fragments can cause nuclear reactions while moving through a sample of uranium. Typically, the fission fragments of ^{235}U have nuclear charges Z~40-50, which suggests that the barriers for Coulomb excitation are low enough to allow fast fragments to excite nuclear isomers. We have calculated the cross section for Coulomb excitation of the 26-minute, 77 eV isomer of ^{235}U. For a typical fission fragment we found that the Coulomb excitation cross section is quite large and can be of the order of 10 barns.

The probability that Coulomb excitation takes place depends on both the cross section and the mean free path of the fragment. We calculated the mean free path of fission fragments in extreme environments as a function of temperature and density (see Fig. 1). For very high densities we find that the fission fragments are stopped locally in the uranium (see Fig. 2). Thus Coulomb excitation of the isomer becomes very improbable, despite the large cross section for the process.

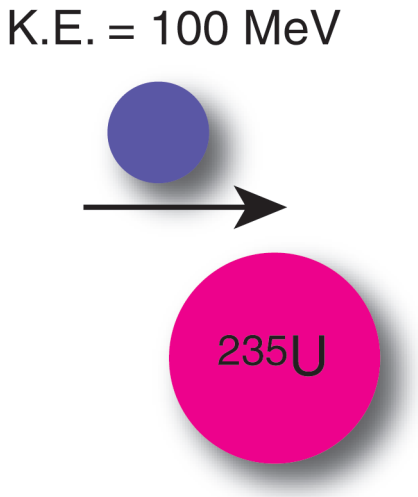

Fig. 1.
The cross section for Coulomb excitation of ^{235}U by fast fission fragments is large. However, in high-density environments the fission fragments are stopped locally.

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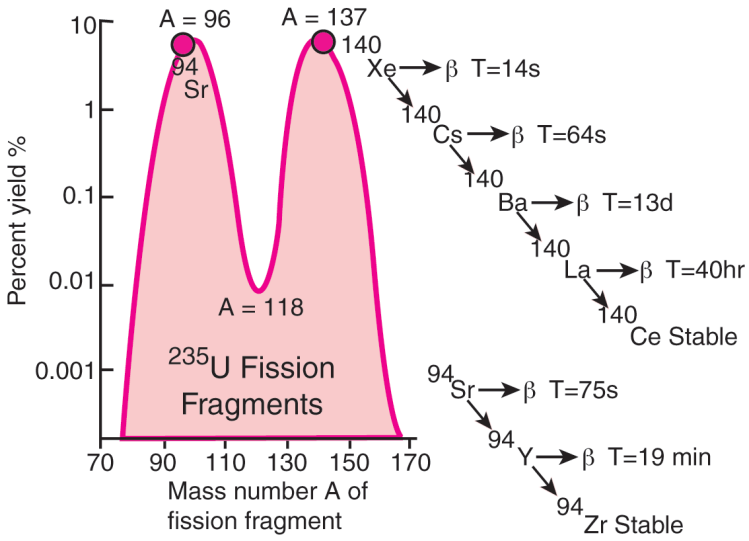

Fig. 2.
Distribution of fission fragments for ^{235}U.